Subalpine Ecology by Karla Tanner, Park Ranger

THE SETTING

It is often said that traveling from the Nisqually Entrance to Paradise is the same as traveling from Puget Sound to the Arctic Circle in a straight line. In general a difference of 1000 feet in elevation is equivalent to a difference of 300 miles in latitude or three degrees in temperature.

If temperature and moisture were uniform at a given altitude, the boundaries of where plants and animals could survive would be as distinct as contour lines on a topographic map. However there is no distinct line of demarcation and there is often considerable variation in the altitudinal distribution of plants. On northern exposures, for example, the lack of sunshine results in lower temperatures and higher soil moisture. Plants which normally occur at 5000 feet on a sunny southern exposure may be found only at a lower elevation on northern slopes, and vise-versa.

Such variation is even more marked in the distribution of mammals and birds. Many species are characteristic of more than one area in relation to the season of the year, the scarcity or abundance of food, or other factors.

Paradise is considered to be a subalpine environment. THE CLIMATE is characterized by short, cool growing seasons and long snowy winters. Snow flurries may come at anytime during the year but generally snow starts staying on the ground starting in mid-October. The greatest snowpack is generally 15 feet to 20 feet deep and occurs during February or March. The weather station located along the Nisqually Vista Trail measures an average of 630 inches of snow fall during the snow year of July 1 - June 30, with snow often staying on the ground there until the first week of July. Elsewhere around Paradise snow might take much longer to melt than early July, especially on north-facing slopes or in valleys where it accumulates to a greater depth. During the winter of 1971-72, 1122 inches (93 ½ feet) of snow fell at Paradise -- almost twice as much as the average. Two winters later, over 1000 inches of snow again blanketed the meadow. The snowpack was correspondently deeper than usual during those years and cooler areas of the meadow never completely melted out during the summers which followed.

Record amounts of snow fall at Paradise due to the height of Mount Rainier and due to the mountain's close proximity to the ocean: As air masses blow off the Pacific, they are heavily laden with moisture. Mount Rainier is the first major barrier encountered by these eastward-flowing storms. As the air masses rise in order to move over the top of the mountain and continue their journey across the continent, the air cools. Since cooler air can hold less moisture, the excess moisture condenses in the form of rain or snow.

Because the storms are so heavily laden with moisture when they reach Mount Rainier, the snow which falls on the slopes of this mountain is typically much wetter than snow which falls further inland. Wetter snow takes longer to melt. Consequently snow lingers at Paradise long after a comparable depth of snow has melted in the Rocky Mountains which are much further away from the Pacific Ocean.

The LONG WINTER, coupled WITH A SHORT SNOW-FREE SUMMER growing season is the primary challenge facing plants trying to grow at Paradise.

The second major challenge is the soil. VOLCANIC SOIL is one of the most difficult soils for plant life. It contains little nourishment. The soil is as hard as ground glass to the touch and as gritty. It retains its separateness as individual grains even when wet. Volcanic soil drains so quickly that humus has almost no chance to form in the cool alpine climate. Vegetation has a hard time absorbing moisture before it is lost. Volcanic soil is also extremely abrasive as it contains large amounts of bare rock and rubble. As it dries, it floats away with a breath of wind.

WIND is the third most important challenge. It is a constant presence. Not only does wind lower temperatures by the severity of the chill factor -- a 30 mph wind can lower the temperature 20 degrees -- but wind velocity also erodes soil and increases evaporation. Wind dictates the shape of plants, scatters seeds and pollen, and molds the snow surface into fanciful sculptures. When wind is strong, it carries sand and snow and has a considerable abrasive effect, sandblasting bark and twigs on the windward side of trees. If water is not available to trees or other plants at these times, either because the soil is frozen or because moisture is lacking, strong ground winds

cause plants to wilt as if under severe drought. Wind desiccation is most lethal in winter when it prunes all elevated growth.

A further consideration are local up slope winds which are caused by ground heating in the lowlands. The air at lower elevations absorbs ground warmth from the sun-heated soil; the air expands, rises and cools. At sunset, when the soil on high mountain ridges cools rapidly, the thin air looses its heat quickly and becomes heavier, flowing down slope at night. Cold air drainage at night makes ridges warmer than the bottom of subalpine valleys. Plants and animals unable to survive in cold valleys may find more favorable living conditions on warmer ridges. One need only stand near Myrtle Falls and look toward the Mountain to notice the lack of shrubs and trees in Edith Creek Basin by comparison to the higher ridges all around.

And lastly, ULTRAVIOLET RADIATION and intense light are the fourth major challenge facing vegetation growing on the upper slopes of Mount Rainier. At 14,000 feet, for example, there is twice as much ultraviolet radiation and 25% more light than at sea level.

A short summer growing season, porous volcanic soil, wind, and intense light -- these are the major factors to which vegetation of the subalpine and alpine zones on Mount Rainier must adapt in order to survive. *How* they have met the challenge of living high on the slopes of Mount Rainier is fascinating.

IDENTIFICATION AND SURVIVAL STRATEGIES

TREES

The most abundant tree at Paradise, SUBALPINE FIR is more characteristic of warmer, drier slopes. It can be identified by its rigid, cathedral-spire growth shape of pointy top and stubby upper branches. Although stiff, the branches do not break under the weight of snow since they offer only a small surface on which snow can accumulate. During winter, the longer lower branches are protected from branch-breaking snowfall, cold and desiccating wind by the snowpack.

Although subalpine firs produce viable seeds the growing season at Paradise is often too short, cool and wet for the seeds to survive. (Conversely, at Sunrise, the summer is usually too hot and dry for the seeds to survive.) For the most part these trees spread by *layering*, i.e., new roots and stems sprout from branches lying on soil beneath the parent tree. Of the tree species characteristic of Paradise, subalpine fir is the best at layering.

Layering benefits these trees in several ways: young trees share an established root system with the parent tree; as a group of trees becomes established they begin to exert an influence on their micro environment, i.e. lengthening the growing season because of their black body effect which results in earlier snowmelt; a group of trees provides some protection from wind velocity and desiccation for its individual members; and as wind is slowed through the clump it releases wind-blown soil particles.

In order for tree species to produce cellulose (wood), the temperature must average 50 degrees F for approximately 30 days. So, although treeline on this mountain is generally considered to be about 7000 feet elevation, trees will grow higher on warmer ridges than in valleys where colder air collects. Although temperatures might be more favorable on ridges, living in such exposed locations can be particularly difficult. Harsh drying winds, carrying sharp ice crystals, kill and cut away shoots from the windward side of trees while growth on the leeward side of these trees goes on normally, producing the one-sided appearance know as *flagging*. Height will be stunted when the trees grow higher than the insulating snow pack and the leader is trimmed off by wind action leaving a skirt of growth below a gnarled top. These stunted conifers are sometimes referred to as *krummholz*. Subalpine fir tends to be more common in krummholz formations than other species.

Like all conifers, the needles of the subalpine fir are waxy thus reducing water loss through transpiration. The needles are also edible. Although snowshoe hares prefer more tender flower stems and sedges when they are available during summer, the hares' diet during winter consists of readily-available needles from conifer trees.

Also successful at layering, MOUNTAIN HEMLOCK is the second most abundant tree at Paradise. It is characteristic of wetter locations and can be easily

identified by its drooping leader and long, wispy branches. Even though the branches of the hemlock are long they are also quite flexible. Instead of breaking when snow loads accumulate, the branches flex, loose their snow and bounce back up. Hemlock trees produce short, waxy needles which radiate from the branches in a star-like pattern. As on all conifers, evergreen needles of the mountain hemlock are advantageous in an area where the growing season is short, as it is more energy efficient to use one set of leaves for more than a single season and to replace those leaves individually rather than all at once.

YELLOW CEDAR, PACIFIC SILVER FIR and a very occasional WHITE BARK PINE also grow at Paradise.

Climatic conditions on the west side of the park have generally been favorable for tree establishment since the close of the Little Ice Age (late 1800s). Warm, dry summers favor the survival of the tree seedlings. In the 1960s. park managers noticed large numbers of saplings in the meadow. Dr. Jerry Franklin conducted research into tree establishment patterns. He determined that tree establishment had increased between 1915 and 1940 during warm, dry periods. Subsequent research at Mount Rainier has demonstrated that tree establishment has continued until the present.

SHRUBS

One popular story about the SITKA MOUNTAIN-ASH is that the average depth of the winter snowpack can be told by the height of this shrub. Certainly the snow depth is no lower than its topmost branches. Snow insulates the shrub from winter cold and protects it from drying winter winds. Exposed branches do not survive winter. Until covered by snow, mountain-ash berries remain on the bush where they ferment as autumn progresses, causing some observers to report birds "flying under the influence" after feasting on fermented berries. Although they are rather mealy textured the bright orange clusters of berries are enjoyed well enough by birds such as varied thrush and by small mammals such as chipmunks and ground squirrels.

Huckleberry or blueberry? In the Pacific Northwest the two terms are used interchangeably. Of the 12 species of blueberries which inhabit this region, the CASCADES BLUEBERRY grows at the highest elevation. During summer the tiny bell-shaped flowers of these low-lying bushes are overshadowed by the more colorful blooms of other subalpine plants. But by October blueberry bushes provide 90% of the red-bronze color characteristic of autumn at Paradise. When the berries ripen at Paradise, black bears are more frequently seen in the meadows than earlier in the summer when foraging doesn't yield as tasty of results.

A myriad of tiny, blossoms cover the flowerheads of this shrubby plant named ROSY SPIRAEA. The stamens which stick up from the flowerheads give them a fuzzy appearance and tickle your nose when you try to smell them. The dense foliage provides shelter for many small mammals and birds such as rabbits and grouse.

Above Paradise where heather grows on the fellfields of Muir Snowfield, botanists have found these shrubby, mat-forming plant communities dating to a remarkable 7000 years of age while individual plants can live up to 50 years. PINK HEATHER can also be found throughout subalpine parkland where it generally favors stony soils. The leaves of this heather are waxy to help prevent wind desiccation. Like most flowers of subalpine and alpine environments, this heather is a perennial. It doesn't have to expend valuable energy producing stems and leaves every year but simply adds to what is already established.

WHITE HEATHER favors windy areas above timberline where it forms mats and nestles among the rocks for warmth and wind protection. Unlike the needle-like leaves of other mountain heathers, the evergreen leaves of white heather form tiers of overlapping scales resembling clubmoss. White heather is credited with being naturalist John Muir's favorite flower.

FLOWERS

AVALANCHE LILY and GLACIER LILY base their success on timing rather than brute size. They begin growing at their bulb tips in September, just when their neighbors are dying back. While snow covers these plants for the next eight months or so, holding the soil temperature close to freezing, their shoots inch up to the soil surface. Very few plant species are active at such low temperatures. Without the snow blanket temperatures would be even colder and growth would be impossible. As soon as the snow melts away from the shoots in spring, avalanche lily and glacier lily burst to their full heights, expending in

a few days their disproportionately large reserve of starches. The stems of these little plants can push through the last inch or two of snow by combusting starch to melt a hole in the snow though which they grow. A remarkable adaptation in these and many other early-blooming high-country plants is a thin-fleshed hollow stem used as an internal greenhouse. When stored carbohydrates are burned off during the quick burst of growth, some of the heat produced is retained in the stem, making the internal air temperature warm enough for photosynthesis even when the outside air is not. Waste carbon dioxide from respiration also stays inside, available for synthesis into new carbohydrates. Although glacier lilies favor dry, south-facing slopes and generally only bloom early in the summer, avalanche lilies bloom at Paradise from late May through early August. As summer progresses, look for avalanche lilies along the edges of retreating snowbanks in meadow depressions where snow accumulation is greater, or on shady north-facing slopes, or in cooler alpine elevations. During wet weather, the flowers of both avalanche and glacier lilies droop to protect pollen inside the blossoms.

Like avalanche and glacier lilies, WESTERN PASQUEFLOWER is one of the first flowers to bloom at Paradise. A "fur coat" of fuzzy hair helps protect more delicate areas of the plant. The hairs diffuse the strong alpine light, reducing both the intensity and directness of that reaching the surface of leaves and stem. Although by itself the intensity of the light is not sufficient to upset photosynthesis, it may cause cell damage if combined with high reflection from rock or snow surfaces. The same hairs which protect the plant from excessive light also measurably reduce water loss by keeping drying winds off the plant's stems and leaves, by encouraging condensation of moisture from the air, and by maintaining warmth. Pasqueflower blossoms are heliotropic, meaning that they track the sun's course through the day in order to maximize their exposure to light and warmth. As solar heat receptors in a yet snow-covered meadow, the warm pasqueflower blossoms make an appealing landing zone for pollinators. When flowering in early summer, the plant is only about 5 inches tall. By the time it fruits at the end of the summer it has grown to nearly 24 inches tall and looks much like a mop head. Since the seeds are wind distributed this additional height allows them to be blown further from the parent plant. Pasqueflower is also commonly known as Western anemone.

Although often confused with buttercups, cinquefoils can be identified by remembering that their common name originated form the words meaning *five* and *leaf*. Cinquefoil's five yellow petals alternate with their five green sepals which alternate with their five shorter green bracts. The underside of a SNOW CINQUEFOIL leaf is covered with crinkled hairs, looking like a wool ski sock under the microscope. Another way to distinguish the two plants is to look for the peculiar waxy sheen of the SUBALPINE BUTTERCUP's yellow petals. This sheen reflects away some of the sun's radiant heat--a valuable asset for a plant known as a herald of spring. The glossy surface of buttercup petals also attracts inexperienced insect visitors, such as flies, more effectively than a matte surface. Buttercups start to grow while still under the snow and bloom in the meltwater of receding snowbanks.

As subalpine meadows are released by spring snowmelt, deep reddish shoots of SITKA VALERIAN soon shoot up abundantly. The redness disappears as the foliage matures, lingering longest in the budding flowers but disappearing as they mature to white. Most redness in plants comes from *anthocyanin*, a complex carbohydrate pigment that may be red, blue, or anywhere in between. Anthocyanin is suspected of several functions in high-elevation plants. First, it filters out ultraviolet radiation, which can be a least as hard on plant tissue as on human skin. Ultraviolet is especially intense at high elevation, where there is less atmosphere to screen it, and around the solstice in June, when sunlight is at its peak. In June the high country is still snowbank-chilled, and plant tissues young and tender, so that's where and when anthocyanin is brought out. Second, while reflecting ultraviolet radiation, it also seems to absorb and concentrate infrared, thus heating the plant. Third, anthocyanin is an interim form for carbohydrates on their way up from winter storage. In order to bloom and fruit early in their short growing season, high-country plants store carbohydrates in their roots, and then move them up fast after snowmelt, or even before. In de-reddening, valerian stuffs itself with preserves from the root cellar. Its sweet smell and sturdy flattish cluster of tiny white blossoms make the valerian a good flower for pollination by butterflies. Since butterflies do not hover, they use the flower head as a landing pad on which to rest and open their wings while they sip nectar.

Although sometimes confused with Sitka valerian or Queen Anne's lace, MEADOW PARSLEY can be identified by its open, round-topped clusters of tiny white-to-pinkish flowers. Its minute flowers cluster together in a flat umbrella-like head and are favorites of hover flies. As pollinators, HOVER FLIES come in second only to bees. Flies are especially crucial in high mountain meadows, where bumble bees are the only common bees. Flies mimic the black-and-yellow-banded color pattern of bees and wasps as protection against any predator that ever made the mistake of attacking a bee or wasp. Hover flies even mimic the sound of bees, employing similar wingbeat frequencies. Hover flies, however, have a slender non-furry body. Flowers preferred by flies are usually regular, simple and often open flat, like parsleys and buttercups. Nectar guides are often present and nectar is easily available. Unlike bee flowers, fly flowers usually produce little odor.

Since lupines can often be seen growing in areas where other plants cannot, it was once believed they devoured all of the nutrients from the soil. The plant received a name meaning "wolf" as a result. However, we now know that lupine, like all members of legume family, fertilize the soil as they grow by releasing nitrogen from nodules on their roots. As the soil is improved. other plants can move into the area to grow alongside the lupines. The sheen apparent on the leaves of subalpine BROADLEAF LUPINE reflects away some of the sun's radiant heat, while the hairs keep drying winds off moist surfaces. Alpine or DWARF LUPINE is even more covered with downy hair which gives the plant a soft, pale gray-green appearance. The hairs protect the plant's stomata, the pores through which a plant breathes and represents an environmental response for conserving moisture. When moisture condenses on the leaf, it is directed by the configuration of the leaf whorl toward the center stem where a drop of water can frequently be found long after all moisture has evaporated from neighboring flowers. Lupine flowers produce a sweet scent which can be especially strong on warm days. The purfumey scent serves to attract insects such as mosquitoes and bumble bees as pollinators. Bumble bees prefer blue flowers, the color of most lupine flowers at Paradise.

Bees are the most valuable pollinators of the plant world. BUMBLE BEES, the commonest bees, are in the honey bee family, and have a strong social order though their colonies are relatively small and short-lived. Only the queens eat well enough to survive the onset of winter. The rest of the colony dies in the fall, after the drones and queens have mated. By feeding only a small number of queens per colony in preparation for hibernation, the colony conserves nectar and pollen resources which are scarce in cool climates. Other key adaptations include the use of ready-made insulated nests, typically a mouse or vole burrow; the relatively large, furry bodies and the skill of raising a near-constant body temperature for flight in a wide range of weather conditions, e.g., arctic bumble bees have been seen in flight in a snowstorm at 6 degrees below freezing!

What appear to be bright rose-purple flowers on MAGENTA PAINTBRUSH are really modified leaves called *bracts*. The colorful bracts are designed to attract pollinators such as the rufous hummingbird to the nectar produced by tiny elongated flowers situated on top of the bracts along the stem. Paintbrush is one of several members of the figwort family known to parasitize the roots of other plants. This increases the amount of moisture available to the paintbrush since it virtually steals moisture away from its neighbors. Paintbrush benefits from an abundance of hairy fuzz in the same way as do its neighboring plants such as lupine.

Not all plants of the Hudsonion Zone have ways to conserve moisture. Those plants that do not, adapt to life in subalpine meadows by growing only in areas with a readily available, constant source of moisture. MARSHMARIGOLDs can be found growing in the meltwater of snowbanks as early as May on some southfacing slopes at Paradise. As the summer progresses, they are often seen blooming alongside JEFFREY SHOOTINGSTAR in meadow marshes and along the banks of streams, ponds and wet seepages. And by late summer, LEWIS MONKEYFLOWER are adding clumps of pink flowers along streams where moisture is constantly available to the plants.

Like the related century plant, BEARGRASS grows slowly and favors well-drained soils. New beargrass clumps develop from underground stems but they cannot produce flowers for several years until sufficient new starches are produced and reserved in the roots. After the plant blooms once the entire plant dies. Entire communities of beargrass will sometimes go through several summers without blooming -- then hundreds will bloom during the same season.

The white flowers and small thickened leaves of TOLMIE SAXIFRAGE form a low-lying mat in rocky areas above timberline. The succulent nature of the leaves allows storage of snow meltwater that can be used later in the summer when the barren rocky outcrops have been drained of moisture.

Characteristic of many alpine plants, SPREADING PHLOX forms a dense, low-growing flower cushion which hug rocks for warmth and wind protection. The smooth convex surface, like an airfoil, eases wind over its flower cushion with a minimum of resistance. Even so, as wind blows over these mounds it slows, allowing wind-borne soil particles to fall onto the plant, slowly raising the level of soil within its periphery. At the same time, there is a maximum exposed leaf surface for photosynthesis with minimum exposure to the elements. Temperatures may be several degrees higher inside a cushion plant than outside; the colder it is outside, the greater the difference. Spreading phlox has a deep taproot (8 to 15 feet) which mines water from far below the soil surface.

Mat plants, such as PARTRIDGEFOOT, are also specially adapted to subalpine and alpine conditions but are more spreading instead of tightly cushioned. There is little vertical separation between the leaves, thus a happy balance is maintained between the greatest exposure to light and reflected heat from the soil surface and the least exposure to cold, wind damage and drying. Water coming from the roots has the shortest possible distance to travel to the leaf tip. Less of the plant's energy is spent for production of plant tissue. Dwarfing occurs only in growth shoots; flower size is not affected.

The white spikes of MOUNTAIN BISTORT punctuate the subalpine flowerfields of Paradise from spring through autumn. Their "dirty socks" scent carries far on the breeze. Such a distinctive odor may be one way the bistort helps insect pollinators recognize what flower it is.

Heavy beds of snow lying on steep meadows tend to creep down slope through the winter, scouring off all vegetation at the surface. Woody seedlings are frustrated year after year, while perennial herbs with fat storage roots and fast spring growth, such as the CORN LILY, are favored. Although its flowers are an inconspicuous light green the Corn lily draws a lot of attention with its corn-tassle-like flower heads and large, prominately veined leaves. The young shoots and roots of Corn lily contain toxins which prevent many other species of plants from growing nearby and make it highly poisonous for human consumption. But by late summer when the plants mature these protective toxins will drain from the leaves. Deer and insects will then start munching on the plants.

Thirty to forty lavender "petals" typically surround the MOUNTAIN DAISY's yellow center. The radial symmetry of the flower maximizes the plant's opportunity to absorb sunshine from all directions. This type of flower configuration can be a distinct advantage in an area with a short growing season.

Fluff balls of silky-winged FIREWEED seeds are carried on the wind to settle in burned areas and avalanche tracks where they will sprout the following summer. Like all plants which have a single flower stalk, the fireweed bloom will progress upward on the stalk so that early-opening flowers will not shade later-opening ones. This blooming pattern increases the amount of sunshine a plant receives during the relatively short growing season typical of high elevations.

Last of the flowers to bloom at Paradise, MOUNTAIN BOG GENTIANs grow in small clusters and favor moist meadows and streambanks. The deep blue tubular gentian flower faces upward to the sky and like many gentians it closes when clouds come over or when breathed upon or touched thus protecting its pollen from damage. Pollinating insects are inactive during storms anyway. Since many day insects have an aversion to darkness, tubular flowers like the gentian are often paler toward their bases. Their tiny "windows" make entrance more attractive to pollinating insects.

SEDGE

Late-lying snowbeds allow only an extremely short growing season. Here a plant's ability to grow rapidly is more important that its ability to survive cold. BLACK ALPINE SEDGE is the speed demon among grasslike plants, flowering 5 to 9 days after its release from the last remnants of the winter snowpack. Even the quickest seed-setting is rarely quick enough, so it spreads by rhizomes as well. Leaves are reduced to essentials--no bright petals, just the reproductive parts enclosed in a simple protective envelope. Also, the narrow leaves and stems of sedges are not likely to be torn by wind. Being wind pollinated, sedges do not

need colorful petals nor nectar nor volatile aromatic oil to attract pollinators, but instead produce pollen in superabundance. For wind pollination to be efficient there must be many individuals of one kind, preferably massed close to each other. Sedges are extremely hardy, thriving in the cooler microclimates of the meadows.

SHOWY SEDGE is the most abundant subalpine tall sedge at Mount Rainier. It grows in meadows with moderate conditions--fairly early snowmelt, and deep soil.

LICHEN

Lichens are formed from a fungus and an alga; fungus forms the tough outer layers while the inner layers contain algal cells enmeshed in fungal threads. Scholars today question whether the lichen symbiosis is mutually beneficial. Some call it *controlled parasitism* in which the fungi slowly kill their green partners. Lichen, crusted on rocks or clinging to soil, have the ability to absorb more then their own weight of water after a dry spell. They can carry on food production at any temperature above 32 degrees F and can grow even where snowbanks persist very late into the summer. Lichens that colonize bare rock may occasionally, after centuries of life, death and decomposition, alter the rock enough for plants to grow. But the ability of lichens to break down rock, initiating the long, slow process of succession, has been overrated. It is negligible compared to the effects of frost. Red-orange JEWEL LICHEN marks a pika or marmot perch. The extra nitrate from the animal's urine makes the rock an ideal growing site for this lichen.

The pale, gray-green festoons found on trees from mid-elevations to timberline is known as Old-man's-beard or GOAT'S BEARD LICHEN. Although it is eaten by deer, the apparent browse line at higher elevations is more likely a marker of spring snowpack depth. It relies on spring as a growing season, when day length and temperatures are rising but rain is plentiful.

Lichen's diet of airborne solids makes them extremely sensitive to airborne sulphur dioxide and other pollutants. No lichens survive in the worst urban air. Environmental scientists watch lichen species as a measure of pollution in an airshed over a period of years.

BIRDS

Succulent saxifrage leaves, white heather flowers and seeds make up the bulk of the summer diet for ROSY FINCHES. They will also forage on glaciers for insects that collapse on the snow, numbed by the cold after being carried astray by upvalley winds. Finches nest in high rock crevices and glacial crevasses. Rosy finches have been seen as high as 11,000 feet on Mount Rainier but are often found during summer near Glacier Vista (6300 feet) and Panorama Point (6800 feet). Most of our rosy finches winter east of the Cascades. The finch family name comes from the same Latin root as does the word *frigid.*

Ranging as far north as Alaska, RUFOUS HUMMINGBIRDs are the most northerly of hummingbirds. They are common in subalpine and alpine areas on Mount Rainier from spring through fall and are especially attracted to red flowers such as magenta paintbrush. Ounce for ounce a hummingbird flying has ten times the caloric requirements of a person running. They consume half their body weight in sugar each day. Their needlelike beaks probe into flowers for nectar which they sip for calories. For protein hummingbirds eat small insects and spiders. Rufous hummingbirds, as well as other hummers, become topid at night to conserve energy. Topidity is a state in which the body temperature drops to that of the surrounding air, and both the heart rate and respiration rate decrease dramatically. When nighttime temperatures drop below 60 degrees F, the birds may save as much as 98% of the energy they would otherwise use to maintain their normal body temperature. To avoid winter, these hummingbirds will migrate as far as South America.

Although smaller than their grouse relatives, WHITE-TAILED PTARMIGANs are the largest creatures that make the alpine zone their permanent home. Like other grouse, they rely on camouflage to protect them from predators. In winter ptarmigans molt to pure white plumage and stay on snow as much as possible, crouching low so even their shadow will be smaller and less conspicuous. Ptarmigan's feet and legs are so heavily clad in feathers during winter that they look like pantaloons. The feathers act as snowshoes and provide warm insulation from the cold snow. Once their summer plumage grows in, ptarmigan stay off the snowfields. Adult ptarmigan seem to know when they are changing color and remain on the periphery of snowbanks during the spring and fall molts, in a half-and-half environment that matches their neither-

nor plumage. By summer their mottled gray plumage allows them to melt into the background of their alpine home. Mating time is triggered by the lengthening daylight of spring. Breeding begins sometime in early May. Ptarmigan are monogamous during the breeding period, with a pair bond usually made for life. Once breeding is completed they have no further interest in each other until the following year, when they find each other again. Weather causes the greatest egg mortality, although nutcrackers, falcons and weasels often find ptarmigan eggs when the mother is off the nest. Panorama Point is a likely location to look for white-tailed ptarmigan.

During spring and early summer one is bound to hear a constant, deep hooting sound while hiking at Paradise. No, it is not an owl nor a bear as many people imagine, but a male BLUE GROUSE courting a female. Both this courting "hoot" and the chief visual display of the males - bare yellow patches on the neck - are performed by inflating a pair of air sacs in the throat. Blue grouse feed and nest on the ground and fly only in infrequent short bursts. Grouse relish berries and insects when available during summer but subsist mostly on conifer needles during winter. Like ptarmigan, grouse have feather-insulated feet and appendages which serve as snowshoes to ensure their winter mobility.

VARIED THRUSH are common in the forest and subalpine areas of Mount Rainier. They are similar to robins in appearance but can be identified by their distinctive orange eye stripe and black breast band. Also distinctive to varied thrush is their long and forceful single-note trill.

Known by the alias of *camprobber*, GRAY JAY has opportunistic feeding habits and can be very aggressive. Loose, fluffy plumage makes the gray jay almost silent in flight. It is abundant in forest and subalpine areas of Mount Rainier and can be seen at Paradise throughout most of the year.

Although sometimes mistaken for the gray jay, CLARK'S NUTCRACKER is a much larger bird with a long, straight beak used to crack seeds from coniferous trees.

DARK-EYED JUNCOs are abundant in our forests and subalpine areas. The white outer tail feathers of this six-inch resident bird flash when the junco is in flight.

Western expansion pushed the COMMON RAVEN up to the mountains from the lowlands where it was once as abundant as its relative the crow. Ravens share the opportunistic feeding habits of other jays but also act like raptors consuming rodents, rabbits, insects, worms, nesting birds, bird eggs, moles and frogs.

MAMMALS

Easily identified by the stripes along their cheeks as well as along the sides of their bodies, chipmunks are the smallest of Pacific Northwest squirrels. It is the YELLOW PINE CHIPMUNK which inhabits subalpine areas. Chipmunks are characteristically active during daylight hours and spend most of their time on the ground or in low bushes. They are not often found in the open habitats preferred by ground squirrels and chipmunks seldom climb trees. They feed on seeds, leaves, flower stems and fruit. Chipmunks do not typically depend on a deposit of fat to supply energy during winter. Instead they begin storing food in their dens starting in late September. Their cache of seeds, leaves, flower stems, and fruit is covered over with a layer of grass for better storage. Although chipmunks hibernate, from time to time during winter they dig down through the grass and consume some of their stores.

GOLDEN-MANTLED GROUND SQUIRREL can be identified by the narrow white line above and below the eye and stripes along its sides. This little squirrel is very much like a chipmunk in habits, behavior and ecology.

Of the five species of marmots represented in the Pacific Northwest, it is the HOARY MARMOT which inhabits subalpine areas. A marmot is active for only a few months of the year. It spends this time sunning on rocks and eating flower stems, grasses and succulent herbs. The body fat it adds to its back and tail during summer allows the marmot to spend winter in hibernation. Hibernation can be thought of a form of seasonal migration. The primary impetus for hibernation is probably lowering air temperature. During hibernation, a marmot's heart beats only four to five times a minute. One full breath is taken about every minute. Body temperature is only a few degrees above freezing. Marmots inhabit rocky places where they find shelter in rock crevices and in underground burrows. Eagles, cougars, bobcats, coyotes and bears are their enemies. Since they have no way to defend themselves but to run for their burrows, when danger

is sighted a marmot will issue a shrill whistle to warn its compatriots. Hoary marmots are the largest members of the squirrel family.

PIKAs, small members of the Rabbit family, are about the size of guinea pigs. They inhabit talus slopes and rocky outcrops between 3000 feet and 8000 feet. The soles of their feet are densely furred to provide traction for scampering across slippery rocks. Pikas venture into nearby meadows only a short ways to gather leaves and flower stems which are carried back to the rocks and stacked in small piles for drying in the sun. Pikas dry their food slowly and carefully so that it becomes completely dry before being stored underground. They even take care to move their food piles under the rocks when rain threatens. This prevents their food from rotting during winter. A pika's vegetarian diet is not high in calories. The animal must fill its stomach almost hourly to meet its energy needs. Pikas do not hibernate during winter as chipmunks, ground squirrels and marmots do, instead they stay active under the snow among the rocks. Temperatures beneath the snow cover remain around 26 degrees F, much warmer than the outside air temperature might be during most of the winter. Their ears are small and rounded, less likely to freeze. Their tail is so small as to be almost non-existent, a common characteristic among winter- active animals since small extremities help conserve body heat.

SNOWSHOE HARE is also active throughout the winter but, unlike the pika who is cozy among the rocks under the snow, the hare is active on top of the snow. It doesn't even build a nest or use a burrow to stay warm but retires to shallow depressions called *forms* under shrubs and low tree branches. The diet of the snowshoe hare changes from one of fresh greens during summer to one of conifer buds and shrub bark during winter. The shortening length of the autumn days triggers an internal clock in the snowshoe hare. The hare begins to molt beginning with the tips of its ears and its hind feet. During the autumn molt, its lightweight brown summer fur is replaced by a heavy coat of white winter fur, providing both extra protection against cold temperatures and protective camouflage to confuse predators. Stiff hairs grow between its toes and along the edges of its feet serving the animal as snowshoes. The molt may take weeks to complete but by the time snow covers the ground, the snowshoe hare is completely white. Come spring, the lengthening day length will trigger a return to summer pelage. Snowshoe hares can attain speeds up to 25 miles-per-hour over short distances and can leap up to 10 feet in a single bound.

BLACK BEAR is the smallest and most common of North American bears. Although plant foods dominate its diet, bears also eat small mammals, insects or larvae, blueberry fruit and leaves. Bears prepare their dens with fluffy stuff--ideally cedar bark which stays resilient under the prolonged weight of the bear's body. Between the insulative nest and superlatively thick fur, the bear maintains a body temperature of about 88 degrees F throughout winter, however heart rate may reach a low of eight beats per minute. Typically two to three cubs are born around January. The mother wakes up to give birth, then nurses them mostly in her sleep for the next few months. Even though black bears normally withdraw from any contact with people, bears should always be considered dangerous--especially sows with cubs. Black bears are good tree climbers, swim well and can run 25 mph for short stretches.

BLACKTAILED DEER and mule deer were considered two distinct species until fairly recently. Now they are lumped together. In winter, deer seek *thermal cover* on steep south aspects just above river bottoms. The low elevation and insulating conifer canopy offer warmer temperatures, shallower snow, and more shrubs to browse. As snow melts, deer move up slope to subalpine meadows. Antlers, made of solid bone and usually branched, are a defining characteristic of the deer family. In late winter the antlers weaken at their bases and fall off. A new pair begins to grow by early summer. Antlers exist to help establish dominance among males for access to females during the rut.

RED FOXes prefer timberline and other areas of broken forest cover. They are largely nocturnal, shy and elusive but are often seen at Paradise during winter nights by campers who have left food outside their tents and igloos. An adult fox does not sleep in a den during winter. Instead a fox will curl its tail around its nose to form a warm furry package. The fox may become covered by snow during a storm--perhaps some of the small, snowy hummocks skiers see during winter are actually sleeping foxes! Red foxes mate in mid-winter and bear their litter in early spring. Like human siblings, red fox littermates may be blond, dark or red. All have white tail tips. Foxes prefer to eat mice, hares, frogs, squirrels and young marmots but also eat lots of insects, fruit and seeds.

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* Don't be scared off by the thickness of these books! They are the *best* sources of information on this list for local ecology. Remember: there are more effective ways to find information than sitting down to read a book cover-to-cover! Use the chapter titles and index of each book to locate specific subjects.

rev. 01/97kt

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